Chapter 11

ACTUATOR, ROTAX, TYPE A0704

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LEADING PARTICULARS

Actuator, Type A0704	*Ref. No. 5W/1111*
Voltage	*28V d.c.*
Normal load	135 *lb.*
Maximum load	240 *lb.*
Current for normal load at 24V	*2·3 amp. (max.)*
Current for maximum load at 24V	*2·6 amp. (max.)*
Length of stroke	3 *in.*
Time of stroke on normal load at 24V	66 *sec.* ±18 *sec.*
Rating	*10 min., or ten complete cycles at 135 lb. load*
Operational temperature range	*— 40 deg. C to +90 deg. C*
Minimum brush length	*0·260 in.*
Brush spring pressure	*3 to 4 oz. (85 to 113 gm.)*
Overall dimensions—	
Length (extended)	13·916 *in.* $^{+0\cdot010}_{-0}$ *in.*
Length (retracted)	10·916 *in.* $^{+0}_{-0\cdot010}$ *in.*
Width	*2·250 in.*
Height (over plug)	*3·812 in.*
Weight	*2lb. 12oz.*

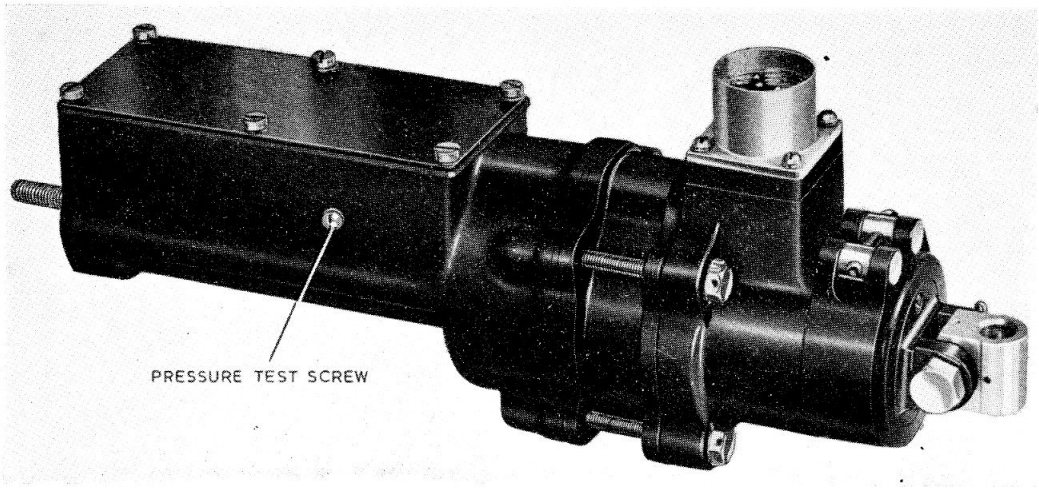

Fig. 1. General view of actuator

Introduction

1. The Type A0704 linear actuator is designed to operate up to a maximum load of 240 lb., with a maximum load current of 2·6 amperes. It has a working load of 135 lb., at a normal load current of 1·75 amperes, with a rating of 10 complete cycles at this load.

DESCRIPTION

2. The actuator consists of a 24 volt d.c., series wound motor, driving through a spring-loaded, single plate clutch, and electro-magnetic brake, to a three stage epicyclic reduction gearbox. The final drive is applied to a ram screw shaft, which operates the ram.

3. The clutch is fitted to prevent damage to the motor and gearbox, in the event of overloads.

4. The electro-magnetic brake is designed to bring the unit to rest, within a maximum ram travel of 0·005 in.

5. Two "quick-break" switches are connected in the series field of the motor, to interrupt the supply at pre-determined limits of ram travel.

Housing and covers

6. The actuator assemblies are contained in three light alloy housings; the first encloses the motor, the second the clutch and brake, while the third housing accommodates the gearbox, the hollow ram; with ram screw shaft, and two limit switches.

7. The motor housing is provided with windows, for access to the commutator brushes. A steel sleeved shackle is formed integrally with the commutator end wall of housing. There is a flanged face to this housing, providing a seating for mounting the five pole plug, which connects up to the electrical supply.

8. The commutator end bearing for the motor is housed in the end wall of the housing. Two grub screws secure the yoke and field coil assembly, relative to the brushgear. The brushgear carrier is secured to the housing by 2 screws. The motor housing is flanged for mating to the clutch and brake housing.

9. The clutch and brake housing is the centre housing, and is flanged on each side, to mate with the motor housing, and the gearbox and ram housing respectively.

10. The gearbox and ram housing is counterbored and threaded at the outer end of its bore, to receive the ram gland nut, and also to provide a seating for the gland.

11. Four main bolts secure the three housings together, passing through, both the motor housing, and the clutch and brake housing. They are screwed into holes tapped in the flange of the gearbox and ram housing, the whole forming one complete unit.

12. The gearbox and ram housing is drilled and tapped to hold a special test screw

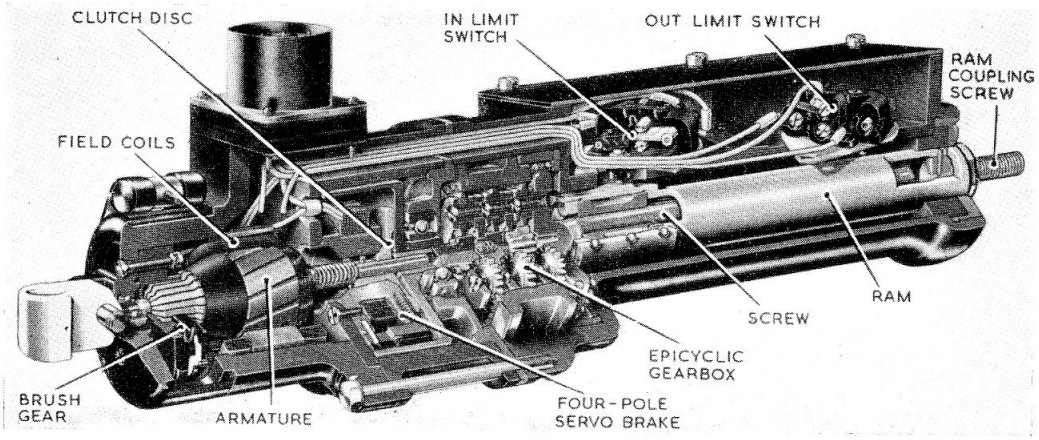

Fig. 2. Sectional view of actuator

(*fig.* 1), for pressure testing. This screw is normally sealed, and must not be removed, except when a pressure test is necessary.

Motor

13. Power supply for the ram operation is from a 24 volt, d.c., 2 pole, series wound motor. The series field of the motor is split into two coils of equal resistance; one coil is in circuit to extend the ram, and the other to retract it. The yoke and pole pieces are constructed integral with one another, from one set of laminations. The armature is supported at the commutator end by a ballrace, and at the drive end by an oilite bush, which is located in the brake drum. Supply to the armature is from a five pole connecting plug, to a brush-gear assembly, comprising; a moulded carrier ring, a terminal block, and two carbon brushes. The brushes are held in position on the commutator by flat coiled springs.

Gearbox

14. The first stage sun gear of the three stage epicyclic gearbox is machined to an extension on the hub of the brake drum. This sun gear meshes with the first stage planet gears (which, in turn, mesh with the annulus gear), rotating about bushes carried on stub pins rivetted to the planet gear carrier. The second stage sun gear is splined to the planet gear carrier, which, in turn, transfers the drive to the second planet gear assembly, similar to the first. The sun gear of this assembly, transfers the drive to the third stage planet gears, the carrier of which is an integral part of the ram screw shaft.

Clutch

15. The spring-loaded single plate clutch is located on the armature shaft between the oilite bush and the armature windings. The clutch plate is formed integrally with a sleeve that is free to slide on the shaft but is prevented from rotating about it by a driving pin passing through the armature shaft and engaging two slots in the sleeve. The driving pin also serves to retain the clutch spring which is located on the armature shaft, between the pin and the armature core end face. The clutch spring normally bears against the driving plate sleeve. A machined face on the inner circumference of the brake drum body, is used as the clutch driven plate.

Electro-magnetic brake

16. The electro-magnetic brake is located on the armature shaft extension, between the brake drum, and anchored to the brake housing by four screws. The brake has an eight pole spider, the eight poles being arranged in four pairs, each pair of poles controlling one brake shoe; the latter are equally spaced around the poles. The outer faces of the brake shoes are cork lined, and are forced by the brake loading springs, against the inner periphery of the brake drum, when the motor is de-energized. The inner periphery of the brake shoes are

copper plated, to counteract their tendency to stick to the pole faces, due to residual magnetism, when the motor is at rest.

Ram and screw shaft mechanism

17. The ram is positioned on its shaft by a sleeve nut. The sleeve nut is retained in position in the hollow ram, by a ring nut locked by metal caulking, and is prevented from turning in the ram by a dowel pin. The ram is prevented from rotating in its housing, by two sets of " anti-torque " steel balls, which are carried in seatings in the tail of the ram. These steel balls are located in two diametrically opposed, internal channels in the ram housing. A cam is ground on the tail, or inner end of the ram; this cam actuates the "out" and "in" limit switches, when the ram travel is "extended" or "retracted" to its pre-determined limits.

18. The ram screw shaft is screw threaded $\frac{5}{16}$ in. B.S.F., along its length; this screw thread engages with the sleeve nut, to drive the ram. The third stage planet gear carrier, which is an integral part with the driven end of the screw shaft, is extended radially, to form one bearing face, for each of the two uncaged ball races. The ball races support the ram screw shaft, and each ballrace takes the linear thrust in one direction. The ram " extension " thrust load is taken through the planet carrier plate, and one ballrace, by the end face of the annulus gear. The " retraction " thrust load is transferred through the carrier plate, and the second ballrace, to a hardened steel track ring, which is located in an extension to the ram housing, enclosing the gear train. The two ballraces are radially enclosed by a steel ring, which, is a snug fit in the ram housing extension. These ballraces combine, to take the radial load imposed, in centralising the screw shaft, when the ram is " extented ", they also position the track ring, when the ram is " retracted ".

Limit switches

19. Two " quick break " switches are connected, each in one half of the motor series field circuit, to limit the " extension " or "retraction", of the ram travel. These limit switches, one controlling the "out" field circuit, and the other the "in" field circuit, are mounted in a box, which forms part of the ram housing, and are so positioned that their trip arms protrude through slots in the housing, at opposite ends of the ram chamber.

20. The limit switch arms come into contact with the cam on the tail of the ram, interrupting the motor circuit, thus, controlling the "extension" and "retraction" of ram travel. Small changes in ram travel can be effected by adjusting the switch base mounting holes which are slotted for this purpose. The switches are initially adjusted, to give accurate pre-determined limits of ram travel, and should not be reset, after installation in the aircraft.

INSTALLATION

21. For details of the installation of actuator, reference should be made to the relevant Aircraft Handbook.

OPERATION

22. With no electrical supply to the actuator, the ram is in the retracted position: the "out" limit switch is closed, completing one half of the motor series field circuit, to extend the ram; at the same time, the "in" limit switch is open. The brake shoes, of the electro-magnetic brake, are forced against the inner periphery of the brake drum, by loading springs.

23. When the actuator is connected to the electrical supply, the circuit is completed through the motor, and a current will flow through the "out" field coil circuit; the solenoid of the electro-magnetic brake, and the armature. The brake coils are energized, withdrawing the brake shoes, from contact with the drum, against the tension of the loading springs. The brake drum is now free to rotate, allowing the armature to speed up, in its magnetic field.

24. Machined to an extension of the brake drum is the sun gear, which revolves, and transmits the motion, through the epicyclic gearbox, to the ram screw shaft. The shaft rotates, and extends the ram to the pre-determined limit of its travel. The cam on the tail of the ram trips the "out" limit switch; opens the "out" motor field circuit, and de-energizes the electro-magnetic brake. The loading springs assert themselves, and force the brake shoes against the inner periphery of the brake drum, and the motor stops.

25. The operation for retracting the ram, is in reverse to that previously described: the "in" limit switch is now closed, and the "out" limit switch is open, with the ram in the "extended" position.

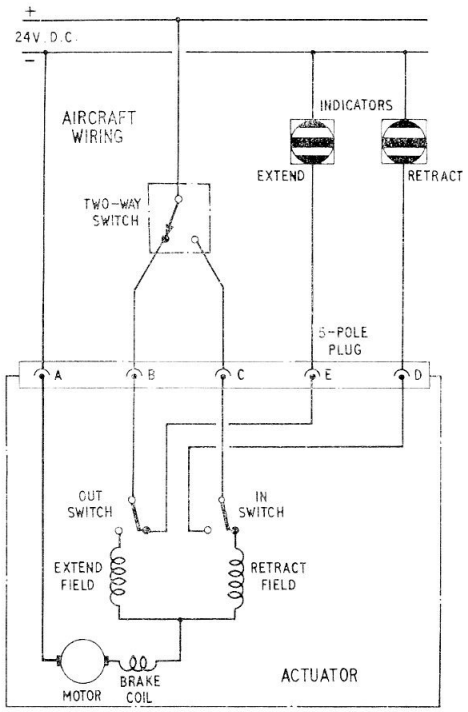

Fig. 3. Wiring diagram

26. At any intermediate position of the ram, both limit switches are closed. Further operation of the control switch, will reverse, or stop the motor, as required.

SERVICING

27. This actuator should be serviced in accordance with the general information in A.P.4343, Vol. 1, Sect. 17, Chap. 2, and the instructions contained in the relevant Servicing Schedule.

Brushgear

28. The minimum length beyond which brushes must not be used is 0·260 in. Brushes should be renewed at periods prescribed in the relevant Servicing Schedule, and whenever examination reveals that they will not remain serviceable for the period that must elapse before the next servicing.

29. Brush spring pressure should be measured by a tension gauge (Ref. No. 1H/59), and should be between 3 and 4 oz. (85 and 113 gm.).

Lubrication

30. This type of actuator is sufficiently lubricated during manufacture, and should not require attention except during repair, when grease XG-275 should be used.

Testing

31. If the serviceability of the machine is suspect, it may be tested as laid down in Appendix A.

Appendix A

STANDARD SERVICEABILITY TEST FOR ACTUATOR, ROTAX, TYPE A0704

Introduction

1. The following tests may be applied to the actuator before it is put into service, or at any time when its serviceability is suspect.

Test equipment

2. The following test equipment is required:—

(1) Linear actuator test rig (Ref. No. 4G/5420).

(2) Tension gauge (Ref. No. 1H/59).

(3) Insulation resistance tester, Type C (Ref. No. 5G/152).

Testing

Brushgear

3. Check the brush length and brush spring pressure; the brush length should be not less than 0·260 in., and the spring pressure should lie between 3 and 4 oz. (85 and 113 gm.).

Performance test

4. Set the actuator on the test rig, and ensure that it operates within the limits given below. The test must be made for both tension and compression loads, and at 24 volts.

Load (lb.)	Maximum current (amp.)	Time for 3 in. stroke (sec.)
0	1·85	42—60
135	2·3	48—84
240	2·6	75—135

5. The actuator must operate on 18 volts against a load of 135 lb.

Insulation resistance test

6. The insulation resistance, when measured with a 250-volt insulation resistance tester between all live parts and the frame, should not be less than 0·05 megohm.